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Management of morning glory (*Ipomea hederifolia, Ipomea nil*, and *Merremia aegyptia*) with herbicides in raw sugarcane during dry seasons[1]

Manejo de cordas-de-violas (***Ipomea hederifolia***, ***Ipomea nil*** *e* ***Merremia aegyptia***) *com herbicidas em cana crua na época seca*

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Abstract - The present research was carried out in a raw ratoon cane area located in Bocaina, SP, with cultivar RB85-5156, planted with a space of 1.4 m between the rows, on a sandy soil, with the objective of studying management alternatives with herbicides applied in the pre-emergence period during the dry season, adopting the randomized blocs design with four replications. In order to apply the herbicides, a CO_2 pressurized backpack sprayer was used, with a constant pressure of 200 kgf.$^{-2}$ and a reservoir with capacity for 2 L of solution, connected to a bar equipped with 6 spray nozzles model DG110.02, with a space of 0.5 m among each, providing an application rate of 200 L ha^{-1}. The evaluations of weed control and phytotoxicity of the herbicides in the crops of sugarcane were done at 30, 60, 90 and 120 DAA. The data went through a variance analysis by the F test and the means were compared by the Tukey test at a 5% probability level. Herbicides diuron + hexazinone + sulfometuron-methyl, amicarbazone, amicarbazone + isoxaflutole, sulfentrazone, imazapic, and tebuthiuron + isoxaflutole can be considered alternatives to the efficient control of different species of morning glory (*Ipomoea hederifolia*, *Ipomoea quamoclit* and *Merremia aegyptia)* when applied to raw sugarcane during the dry season on sandy clay soils (medium texture). Regarding selectivity of the sugarcane crop, there were no significant phytotoxicity symptoms observed on the herbicides when applied in total pre-emergence until 120 DAA.
Keywords: weeds; sugarcane; control; selectivity; straw

Resumo - A presente pesquisa foi conduzida em uma área de cana-soca crua, localizada no em Bocaina, SP, com a cultivar RB85-5156, plantada no espaçamento de 1,4 m entrelinhas, em solo de textura arenosa, com o objetivo de estudar alternativas de manejo com herbicidas aplicados em pré-emergência na época seca, adotando-se o delineamento em blocos casualizados com quatro repetições. Para a aplicação dos herbicidas, foi utilizado um pulverizador costal, com pressurizador de CO_2, a uma pressão constante de 200 kgf.$^{-2}$, e reservatório com capacidade para 2 L de calda, conectado a uma barra equipada com 6 pontas de pulverização modelo DG110.02, espaçados 0,5 m entre si, a uma velocidade de deslocamento de 1 m s^{-1}, proporcionando uma taxa de aplicação de 200 L ha^{-1}. As avaliações de controle de plantas daninhas e fitotoxicidade dos herbicidas na cultura da cana-de-açúcar foram realizadas aos 30, 60, 90 e 120 DAA. Os dados foram submetidos

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à análise de variância pelo teste F e as médias comparadas pelo teste de Tukey ao nível de 5% de probabilidade. Os herbicidas diuron + hexazione + sulfumeturon-methyl, amicarbazone, amicabazone + isoxaflutole, sufentrazone, imazapic; e tebuthiuron + isoxaflutole podem ser considerados como alternativas de controle eficazes para as diferentes espécies de corda-de-viola (*Ipomoea hederifolia, Ipomoea quamoclit* e *Merremia aegyptia)* quando aplicados em cana-crua na época seca em solos areno-argilosos (textura média). Em relação à seletividade da cultura da cana-de-açúcar, não foram observados sintomas significativos de fitotoxicidade dos herbicidas quando aplicados em pré-emergência total até o 120 DAA.
Palavras-chaves: plantas daninhas; cana-de-açúcar; controle; seletividade; palha

Introduction

One of the most critical points in the sugarcane productive process is the capacity to interfere on the development and productivity imposed by the weeds (Pitelli, 1985, Kuva et al., 2008, Toledo and Negrisoli 2011).

The interference intensity between an agricultural crop and an infesting community depends on factors connected to the crop itself, such as variety, spacing and planting density; factors connected to the infesting community, such as specific composition, density and distribution of individuals on the crop; and to the time and the period in which the crop and the infesting community coexisted (Pitelli, 1985). In addition to competing with the grown plant, the weeds can interfere with the crop practices, especially on the mechanized harvest, reducing its efficiency (Azania et al., 2002).

According to Lorenzi (1995), the presence of weeds on the crops of sugarcane can increase the production costs in up to 30%, in ratoon cane, and from 15 to 25% in sugarcane plant. Therefore, the control of weeds in Brazilian sugarcane fields, which have extensive areas, is basically done through a chemical process, both in pre and post-emergence because of practicality, high efficiency and low control cost, when compared to the other methods (Christoffoleti et al., 2006; Kuva et al., 2008).

The species from genus *Ipomoea*, belonging to the Convolvulaceae family are traditionally known as bellflower or morning glory. Among the many characteristics of this family, the one that stands out is production, of about 50 to 300 diaspores per plant. From these, only a small percentage germinates quickly; the others germinate randomly throughout time (Kissmann; Groth, 1999). Moreover, the seeds of some weeds belonging to the convolvulacea family have their germination powered during summer, due to better heat and humidity conditions (Azania et al., 2009). However, in this period, monitoring and controlling weeds require more attention.

The choice of herbicide and time of application, as well as its distribution, has been done with a defined criterion, but without including all the variables required to maximize the effect of control and reduction of weeds interference with sugarcane. Among these not-considered variables, the better knowledge of the infesting community can be useful to support decisions and make them more insightful (Kuva, et al., 2007).

As an alternative for the chemical control of weeds in sugarcane during the dry season, Toledo et al., 2010, highlight results of herbicide Front® (diuron + hexazinone + sulfometuron-methyl) in the control of several species of morning glory (*Ipomoea hederifolia, Merremia cissoides, Ipomoea grandifolia, Ipomoea quamoclit and Ipomoea nil),* as well as an excellent control of grass (*Brachiaria decumbens, B. plantaginea, P. maximum* and *Digitaria* sp).

Within this context, the objective of the present research was to evaluate the efficacy of pre-emergent herbicides for the management of different species of morning glory *(Ipomoea hederifolia, Merremia aegyptia* and *Ipomoea*

nil) when applied during the dry season (July) on a sandy clay soil, raw sugarcane area.

Material and Methods

The current research was carried out in a raw ratoon cane area located in the city of Bocaina, SP, with cultivar RB85-5156, planted with a space of 1.4 m between the rows, on a sandy soil.

The behavior of the six treatments on the control of weeds of sugarcane crops was studied with the conventional application to the straw from the mechanized harvest in a system of raw cane, in addition to the control plot. The treatments applied were: [diuron + hexazinone + sulfometuron] – [1386.9 + 391 +33.35 g a.i. ha^{-1}] (Front® 603 – 107 – 14.5 g kg^{-1} of a.i., WG, DuPont); amicarbazone – 1225 g a.i. ha^{-1} (Dinamic® 700 g kg^{-1} of a.i., WG, Arysta LifeScience); the association of amicarbazone – 840 g a.i. ha^{-1} (Dinamic® 700 g kg^{-1} of a.i. , WG, Arysta LifeScience) and isoxaflutole – 75 g a.i. ha^{-1} (Provence® 750 g kg^{-1} of a.i., WG, Bayer CropScience); sulfentrazone – 900 g a.i. ha^{-1} (Boral® 500 g L^{-1} of a.i., SC, FMC); imazapic – 154 g a.i. ha^{-1} (Plateau® 700 g kg^{-1} of a.i., WG, BASF) and association of tebuthiuron 900 g a.i. ha^{-1} (Combine® 500 g L^{-1} of a.i., SC, Dow AgroSciences) and isoxaflutole – 75 g a.i. ha^{-1} (Provence® 750 g kg^{-1} of a.i., WG, Bayer CropScience).

The dosages of herbicide treatments used, in active ingredient, are described on Table 1. The efficiency of the control of herbicides applied during the dry season (Figure 1) was evaluated in the pre-emergence period of the sugarcane crop and weeds, that is, of the thee species of morning glory: *Ipomoea hederifolia*, *Ipomea nil* and *Merremia aegyptia*.

Table 1. Treatments used in the control of weeds in the sugarcane crops. Bocaina (SP), 2011.

Active ingrediente	Dose (g a.i. ha^{-1})
1. [diuron + hexazinone + sulfumeturon-methyl]	[1386.9 + 391 + 33.35]
2. amircarbazone	1225
3. amircarbazone + isoxaflutole	840 / 75
4. sulfentrazone	900
5. imazapic	154
6. tebuthiuron + isoxafluote	900 / 75
7. Check without herbicide	-

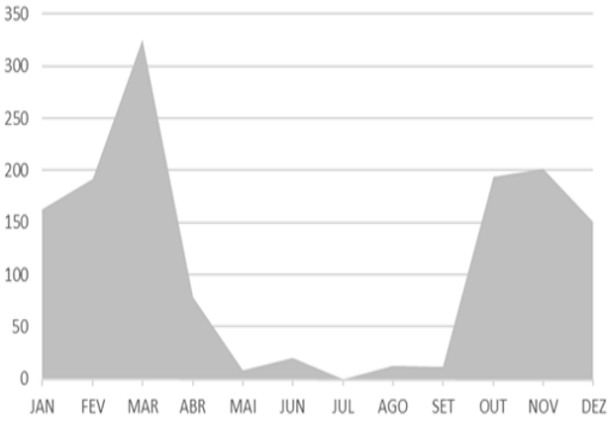

Figure 1. Rainfall data (mm) during the period of this research. Bocaina (SP), 2011.

The experimental units presented dimensions of 6 meters wide across 8 meters long, amounting to an area of 48 m². However, the useful area was 42 m² considering the central region of each plot.

In order to apply the herbicides (05/10/2011), a CO_2 pressurized backpack sprayer was used, at a constant pressure of 200 $kgf.^{-2}$, and with a reservoir with capacity for 2 L of solution, connected to a bar equipped with 6 spray nozzles model DG110.02, with a space of 0.5 m among each, at a travel speed of 1 m s^{-1}, providing an application rate of 200 L ha^{-1}.

Four visual evaluations were done on the efficacy of the herbicides in the control of morning glory species and possible injury symptoms (phytotoxicity) to sugarcane. These evaluations happened at 30, 60, 90 and 120 days after the application (DAA) of the herbicides.

The procedure of control evaluations was done by attributing visual percentage scores, relating to the control treatment, in which 0% represented the absence of control and 100% the death of the weeds, and for phytotoxicity 0% represented the absence of toxicity symptoms or injury to the sugarcane crop, and 100% the death of sugarcane plants, according to what was proposed by the Brazilian Society of Weed Science - SBCPD (1995).

The experimental outline adopted was of randomized blocks, amounting to seven treatments with four repetitions. The results obtained were submitted to a variance analysis by the F test, with a significance level of 5% probability, and the means of the treatments were compared by the Tukey test at a 5% significance with the help of the statistics software Sisvar 5.1 (Ferreira, 2011).

Results and Discussion

On Table 2 it is possible to see the average results observed of the control percentage for the three species of morning glory studied and evaluated during this research. Analyzing the effects of herbicides control on the species *Ipomoea hederifolia*, an excellent efficacy of every herbicides and associations studied from 30 to 120 DAA can be seen.

At 120 DAA, it is observed that the treatments with herbicides diuron + hexazinone + sulfumeturon; amicarbazone; the association of amicarbazone and isoxaflutole; sulfentrazone and the association of tebuthiuron and isoxaflutole presented excellent levels of efficacy with control percentages of 99 to 100%, while the treatment with imazapic provided a very good control result (95%). However, it is important to highlight that there were no statistical differences at 120 DAA.

Morning glory, also known as hairy merremia (*Merremia aegyptia)* was efficiently controlled by all treatments proposed in the different evaluation periods (30 to 120 DAA). However, it is observed that at 30 DAA, the smallest control means observed is associated to the association of herbicides amicarbazone and isoxaflutole with 97%, which is considered excellent control, and there was no statistical difference among the other herbicide treatments (Table 2).

At 120 DAA, it is observed that the treatments with herbicides diuron + hexazinone + sulfumeturon; amicarbazone; the association of amicarbazone and isoxaflutole; sulfentrazone, and the association of tebuthiuron and isoxaflutole presented excellent levels of efficacy with control percentages of 100%, while the treatment with imazapic provided an excellent control (99%). However, it is important to highlight that there were no reports of statistical differences at 120 DAA.

According to Correia and Kronka Jr (2010), creeper species became more troubling in agricultural environments, not only because of their interference in the productivity capacity of the grown plant, but also due to the difficulty when harvesting. This causes losses in the yield of machines, in the case of mechanized harvest, and even manual cutters in the cutting of sugarcane. Even in a low "scape" condition, the surviving individual can be enough to cause harvest damage. Therefore, an efficient herbicide treatment in the control of creeper species such as the ones from genus *Ipomoea or Merremia*, will be the one that results in the highest control percentages, with a minimum of "scape" or regrowth of sprayed plants.

For the morning glory species *Ipomoea nil*, it can be observed that the several herbicides and associations presented results with significant differences from 30 to 120 DAA. In the initial period, that is, at 30 DAA, herbicides diuron + hexazinone + sulfumeturon; amicarbazone; the association of amicarbazone and isoxaflutole; sulfentrazone and the association of tebuthiuron and isoxaflutole presented excellent levels of efficacy with control percentages of 92%, while the treatment with imazapic provided a regular to unsatisfactory result (64%).

Table 2. Average control percentage of *Ipomoea hederifolia*, *Merremia aegyptia and Ipomoea nil* by herbicides diuron + hexazinone + sulfometuron-methyl and other herbicides in the sugarcane crops. Bocaína (SP), 2011.

Treatments	Dose (g a.i. ha^{-1})	*Ipomoea hederifolia*			
		30 DAA	60 DAA	90 DAA	120 DAA
1. [DIU + HEX + SMM]	[1386.9 + 391 + 33.35]	95 ab	95 ab	97 ab	99
2. AMI	1225	100 a	100 a	100 a	100
3. AMI + ISO	840 / 75	99 a	99 ab	99 a	99
4. SFT	900	100 a	100 a	100 a	100
5. IMA	154	85 b	90 b	93 b	95
6. TEB + ISO	900 / 75	100 a	100 a	100 a	100
F	-	4.78*	2.93*	3.35*	2.18^{ns}
CV (%)	-	4,70	4,20	2,80	2,40
Treatments	Dose (g a.i. ha^{-1})	*Merremia aegypta*			
		30 DAA	60 DAA	90 DAA	120 DAA
1. [DIU + HEX + SMM]	[1386.9 + 391 + 33.35]	99	99	100	100
2. AMI	1225	100	100	100	100
3. AMI + ISO	840 / 75	97	99	100	100
4. SFT	900	99	100	100	100
5. IMA	154	99	99	99	99
6. TEB + ISO	900 / 75	100	100	100	100
F	-	0.79^{ns}	0.87^{ns}	2.45^{ns}	1.00^{ns}
CV (%)	-	4.30	2.40	0.80	0.80
Treatments	Dose (g a.i. ha^{-1})	*Merremia aegypta*			
		30 DAA	60 DAA	90 DAA	120 DAA
1. [DIU + HEX + SMM]	[1386.9 + 391 + 33.35]	85	92 ab	95 a	96
2. AMI	1225	92	96 a	98 a	97
3. AMI + ISO	840 / 75	87	90 ab	91 ab	95
4. SFT	900	90	92 ab	95 a	95
5. IMA	154	64	74 b	78 b	87
6. TEB + ISO	900 / 75	92	96 a	96 a	96
F	-	2.02^{ns}	2.92*	3.56*	2.12^{ns}
CV (%)	-	15.60	9.20	7.20	5.10

DIU = diuron; HEX = hexazinone; SMM = sulfumeturon-methyl; AMI = amicarbazone; ISO = isoxaflutole; SFT = sulfentrazone; IMA = imazapic; TEB = tebuthiuron. ^{ns} Non-significant. * Means followed by the same letter, on the columns, do not differ statistically from each other by the t test at a 5% probability.

In the period of 60 to 120 DAA, all the herbicide treatments presented levels of efficacy considered excellent (96 to 98%), while the treatment with imazapic provided a good control result (87%).

Regarding selectivity of the herbicide treatments studied in this research, it is possible to see phytotoxicity characterized as mild (symptoms of chlorosis on the sugarcane leaves) until 60 DAA for the treatment with herbicide imazapic — 154 g a.i. ha^{-1}, even when applied in total pre-emergence of the raw sugarcane crop during the dry season.

On the other hand, the sugarcane plants from the plots treated with herbicides diuron + hexazinone + sulfumeturon; amicarbazone; the association of amicarbazone and isoxaflutole; sulfentrazone and the association of tebuthiuron and isoxaflutole did not present any phytotoxicity in the period of 0 to 120 DAA (Table 3).

Table 3. Average of phytotoxicity (%) promoted by herbicides applied in sugarcane. Bocaína (SP), 2011.

Treatments	Dose (g a.i. ha^{-1})	Phytotoxicity			
		30 DAA	60 DAA	90 DAA	120 DAA
1. [DIU + HEX + SMM]	[1386.9 + 391 + 33.35]	0 b	0 b	0	0
2. AMI	1225	0 b	0 b	0	0
3. AMI + ISO	840 / 75	0 b	0 b	0	0
4. SFT	900	0 b	0 b	0	0
5. IMA	154	12 a	6 a	0	0
6. TEB + ISO	900 / 75	0 b	0 b	0	0
F	-	3.96*	1.98	-	-
CV (%)	-	25.00	25.00	-	-

DIU = diuron; HEX = hexazinone; SMM = sulfumeturon-methyl; AMI = amicarbazone; ISO = isoxaflutole; SFT = sulfentrazone; IMA = imazapic; TEB = tebuthiuron. * Means followed by the same letter, on the columns, do not differ statistically from each other by the t test at a 5% probability.

Conclusions

Herbicides diuron + hexazinone + sulfumeturon (1386.9 + 391 + 33.35 g a.i. ha^{-1}); amicarbazone (1225 g a.i. ha^{-1}); the association of amicarbazone + isoxaflutole (840 + 75 g a.i. ha^{-1}); sulfentrazone (900 g a.i. ha^{-1}); and the association of tebuthiuron + isoxaflutole (900 + 75 g a.i. ha^{-1}) can be considered good alternatives for the management of different species of morning glory (*Ipomoea hederifolia*, *Ipomoea quamoclit* and *Merremia aegyptia),* when applied in pre-emergence and in raw sugarcane during the dry season on sandy clay soils (medium texture).

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